April 3, 1956 G. T. STROKES 2,740,881

IMMERSION HEATER

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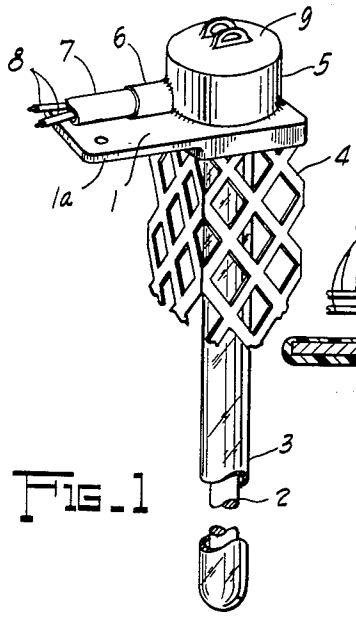


FIG. 1

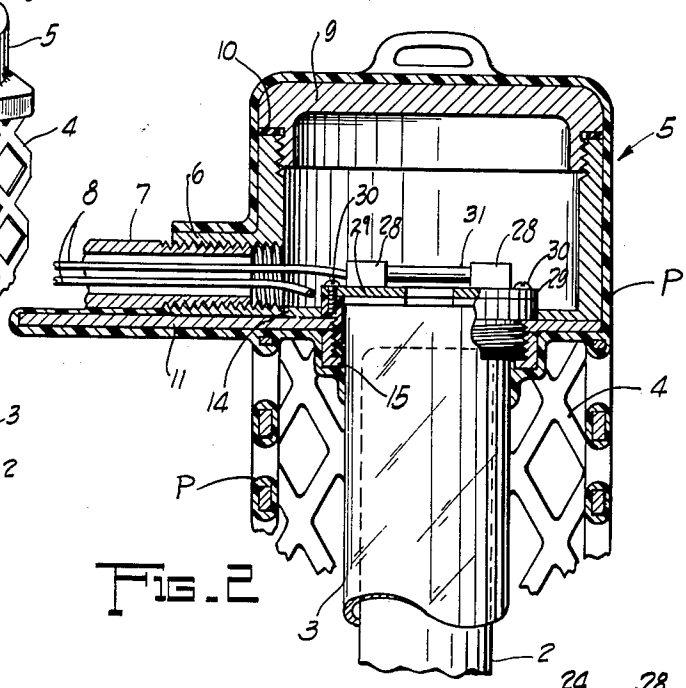


FIG. 2

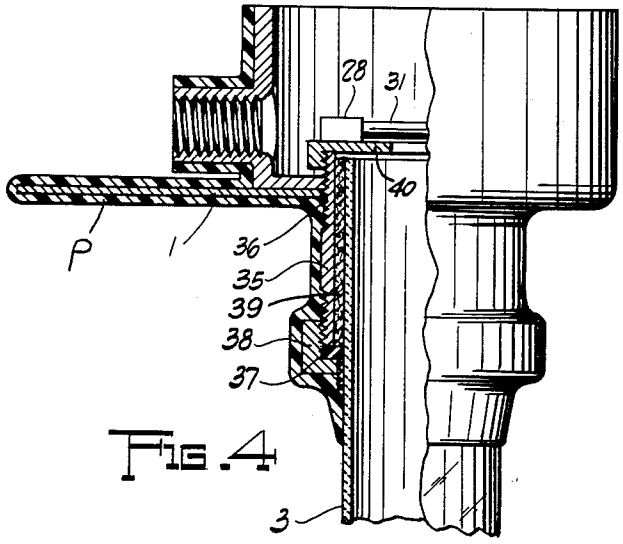


FIG. 4

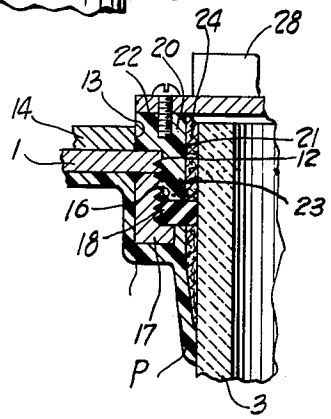


FIG. 3

INVENTOR.
GEORGE T. STROKES
BY
Bosworth, Sessions, Herrstrom & Williams
ATTORNEYS

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IMMERSION HEATER

George T. Strokes, Willoughby, Ohio, assignor to Glo-Quartz Electric Heater Co., Inc., Willoughby, Ohio

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This invention relates to immersion heaters and in particular to an improved construction of vapor-tight quartz sheathed electric immersion heaters.

Electric immersion heaters usually are fully exposed to vapors of the liquid which they heat and therefore protection of the heaters and in particular the electrical connections to the heater from the corrosive effects of such vapors presents a serious problem in the maintenance of such apparatus. The problem is the more acute when the heating of acid, and other solutions which are highly corrosive is involved. Quartz sheathed immersion heaters, that is, heaters, whose heating elements are disposed in closed end fused quartz tubes, present an additional problem of sealing the open end of the tube into which the heating element is inserted. Practice in the past with quartz heaters has been to close off the end of the quartz tube with sealing compounds and to run the electric wires through the compound to a source of power. However, vacuum created in the tube as a result of cooling and condensing of air in the tube when the heater is turned off tends to "breathe in" or draw corrosive vapors of the heated solution through the electric wires and porous sealing compound into the tube with ultimate damage to and even destruction of the heater coils themselves and occasionally causing the heater to explode. Furthermore, sealing the end of the tube closed in this manner makes replacement of burned out heater coils in the tube a tedious and expensive operation which frequently results in damage to or destruction of the tube.

The nature of this problem of sealing quartz sheathed heaters has resulted in limiting the use of safety fuses in the heater circuits to points remote from the heaters to preserve the fuses from the corrosive vapors generated by the solutions being heated. This necessitates a separate mounting box for the fuses and, in installations requiring several heaters for one tank of solution, results in supplying power to a bank of heaters from one fuse box. In event of breakdown of one heater, the entire bank of heaters are taken out of operation with resultant loss of heating and production.

My invention overcomes these problems by providing an improved seal for the end of the quartz tube that prevents any vapor from entering the tube or from affecting the electrical connections and further enables the use of safety fuses in the circuit of each heater at the heater location.

A general object of my invention is the provision of an improved immersion heater that is completely and effectively sealed against corrosive vapors of the heated solution. Another object is the provision of a sheathed immersion heater which is sealed so as to permit the heater to "breathe" without exposing the heater coils to corrosive vapors of the heated solution. Another object is the provision of a vapor-tight immersion heater with electric safety fuses carried on the heater body without danger of corrosion thereof by vapors emanating from the solution being heated. Another object is the provision of a quartz sheathed heater in which the exterior of the

open end of the sheath is firmly supported on and effectively sealed to a vapor-proof junction box so that the tube remains open and unobstructed thereby permitting replacement of heater coils, when necessary, without disturbing the seal of the sheath against the junction box. Another object is the provision of a heater which is simple and rugged in construction, foolproof, and economical to manufacture.

These and other objects of my invention will become apparent from the following description of preferred embodiments thereof, reference being had to the accompanying drawings.

Figure 1 is a perspective view of an immersion heater having a vapor-tight junction box embodying my invention, the lower part of the guard being broken away.

Figure 2 is a central vertical section of the heater shown in Figure 1.

Figure 3 is an enlarged view of a portion of Figure 2 showing the details of construction.

Figure 4 is a view partially in section of a modified form of heater construction.

Referring now to the drawings, the heater made in accordance with my invention comprises a mounting plate 1 by means of which the heater is mounted on the side of a tank or vat, not shown, an immersion heater unit including a vertically disposed elongated resistance wire heating element 2 supported and enclosed in a fused quartz tube or sheath 3, a lattice-like guard 4 for the tube suspended from the underside of the plate 1, and a junction box 5 carried on the upper side of the plate. The side wall of the junction box has a tapped integral tubular extension 6 for receiving the threaded end of a conduit 7 which is sealed thereto and through which wires 8 extend for connection to the heater unit.

The top of the junction box is closed by a removable threaded cap 9 and a gasket 10 which seals the junction and makes it vapor tight. Guard 4 and junction box 5 preferably are permanently secured to the mounting plate as by welding and all exterior and otherwise exposed surfaces of the mounting plate 1, junction box 5, cap 9, and guard are dip coated with an acid-resistant, heat-converted thermal-plastic P such as "Plastisol," which preferably is baked on these parts. This coating preserves the metallic parts of the heater from corrosion and deterioration that would otherwise result from contact with acid solutions and their vapors which such heaters are designed to heat.

In practice, the quartz sheathed heating element and the guard are immersed in the solution to be heated with the outer part 1a of the mounting plate supported on a rim or lip of the tank containing the solution. As the solution comes up to heat, vapors rise around the underside of the mounting plate and envelope the unimmersed parts of the heater in a dense gaseous atmosphere of corrosive fumes which tend to seep through the junction of the quartz tube 3 and the mounting plate and penetrate the interior of the junction box. If this occurs, the wiring and electrical connections within the junction box are quickly corroded and destroyed and hence the seal between the connected parts of the heater assembly, and especially the seal between the quartz tube 3, the mounting plate 1 and junction box 5 must be absolutely vapor-tight. The upper end of the quartz tube 3 is open to permit removal of the heating element 2 for repair or replacement and hence penetration of corrosive vapors into the junction box would also tend to work down into the tube and ultimately destroy the heating element. My invention, inter alia, is directed to the provision of a vapor-tight mechanically strong junction at this critical point of the heater assembly.

The upper end of the quartz tube 3 extends through aligned openings 12 and 13 in mounting plate 1 and

bottom wall 14 of the junction box, respectively, see Figure 3, opening 13 having a larger diameter than plate opening 12 which is threaded and is larger than the diameter of the tube 3. A slip nut 15 brazed to the underside of the mounting plate has a tapped bore 16 axially aligned with and of diameter equal to opening 12 in the plate. The lower end of slip nut 15 is formed with an annular inwardly extending flange 17 on which is seated a resilient ring 18 of corrosion resistant material such as "Neoprene," which serves mechanically to grip and seal the upper end of the quartz tube in the manner explained below.

A bushing 20 having a bore 21 with a diameter slightly larger than the outside diameter of the quartz tube 3 has an upper collar 22 and an externally threaded lower neck 23 engaged in the tapped opening 12 of the plate 1 and in opening 13 of junction box bottom wall 14, respectively. The length of bushing neck 23 is such that when the bushing is threaded downwardly into the slip nut, the lower end of the neck engages and compresses resilient ring 18 against flange 17 of the slip nut and causes the ring to expand radially and mechanically grip and tightly seal against the periphery of the quartz tube. A sealing compound 24 poured into the annular space between the quartz tube and the bushing neck, preferably before the bushing is tightened in the slip nut, makes a gas-impervious vapor-tight bond between the tube, bushing and slip nut for the full length of the bushing and below the ring 18 thoroughly and completely to seal the junction. The tube is mechanically supported by the grip of the compressed resilient ring 18 which constitutes a shock mount for the tube and preserves same against damage during shipment and installation.

An important advantage of this heater construction is the facility with which the heating element 2 may be removed or replaced, the upper end of the quartz tube being open and unobstructed. The quartz tube 3, representing a large part of the overall cost of the heater may therefore be reused many times when the heating element burns out and results in considerable savings in materials and time in the maintenance of the heater. Generally, only the resistance wire in the heating element wears out since fused quartz is practically inert and is not attacked or otherwise affected by any acids with the exception of hydrofluoric acid. It is also possible to effect such replacement of the burned out element at the plant of the ultimate user without necessity of returning the unit to the heater manufacturer.

It will be noted that vapors or fumes from the heated solution cannot enter the junction box and that the atmosphere within it is uncontaminated. Conduit 7 carries fresh air from points remote from the tank to the junction box and quartz tube and effectively vents the interior of the heater unit. Because my heater construction precludes contamination of the interior of the heater by corrosive fumes, I have found it possible and advantageous to provide electric line safety fuses within the junction box of each heater.

The safety fuse assembly, one half of which is shown in Figure 2, comprises conventional fuse clips 28 secured to an insulator 29 mounted on the top of the bushing by suitable means such as screws 30. A fuse 31 makes electrical contact with the fuse clips which are connected in series in the heater circuit. If for any reason the individual heater draws excessive current, fuses 31 open and take the heater out of the circuit. The advantage of fuses mounted on each individual heater is that failure of one heater in a bank consisting of a plurality of parallel connected heaters does not affect the operation of the rest of the heaters in the bank. The defective heater may be repaired or replaced without interrupting the operation of the other heaters and hence production is not impaired.

In Figure 4 is shown a modified form of a heater unit in which an elongated pipe nipple 35 is used in place of

bushing 20 described above, the nipple being brazed as indicated at 36 to the mounting plate 1 and forming a cylindrical enclosure of substantial length for the upper end of the quartz tube 3. The lower threaded end of the nipple seats against the resilient "Neoprene" ring 37 which is compressed and radially expanded by slip nut 38, when screwed on the nipple, into gripping and sealing engagement with the quartz tube. The inside diameter of the nipple, like bushing 20 in Figures 2 and 3, is slightly larger than the outside diameter of the quartz tube, and the annular space therebetween is filled with sealing compound 39 which augments the sealing action of ring 37. The longer length of nipple 35 affords sealing a greater area of the quartz tube against ingress of corrosive gases and vapors. An insulator bushing 40 threaded on the top end of the nipple provides a means for mounting the safety fuse assembly. In other respects the heater construction of Figure 4 is substantially the same as that described in Figures 2 and 3.

Modifications and changes to the above described embodiments of my invention may be made by those skilled in the art without departing from the scope of the invention and hence I wish it understood that these embodiments are given only by way of example. The scope of the invention is defined in the appended claims.

I claim:

1. An immersion heater comprising a tube, a heating element in said tube, rigid junction box means having a central opening through which one end of said tube extends, a resilient expandable ring engageable with and circumscribing said tube near said one end thereof, means carried by said junction box means for compressing and expanding said ring into tight gripping relation with the exterior of said tube for resiliently supporting and sealing same on and to said rigid junction box means whereby the periphery of said one end of the tube is sealed within said junction box means, and electric circuit means connected to said heating element for energizing same.

2. The heater according to claim 1 in which said one end of said tube is open and the opposite end is closed.

3. The heater according to claim 2 in which the end of said heating element adjacent the open end of the tube is unsealed whereby the heating element may be removed from the tube and junction box means without disturbing the connection of said tube to said junction box means.

4. An immersion heater comprising a tube, a heating element in said tube, junction box means having a central opening through which one end of said tube extends, a resilient ring circumscribing said tube near said one end thereof, means carried by said junction box means for compressing and expanding said ring into tight gripping relation with the exterior of said tube for resiliently supporting and sealing same on and to said rigid junction box means whereby the periphery of said one end of the tube is sealed within said junction box means, comprising an internally threaded slip nut secured to said junction box means in axial alignment with said central opening, an inwardly extending annular flange on one end of said nut, said ring being seated on said flange, and a bushing in threaded engagement with said nut, the end of said bushing engaging said ring and compressing same against said flange whereby the ring is expanded radially against said tube, and electric circuit means connected to said heating element for energizing same.

5. The heater according to claim 4 in which the internal diameter of said bushing is greater than the outside diameter of said tube, a gas-impervious sealing compound being disposed between said bushing and said tube.

6. An immersion heater comprising a tube, a heating element in said tube, junction box means having a central opening through which one end of said tube extends, a resilient ring circumscribing said tube near said one end thereof, means carried by said junction box means for compressing and expanding said ring into tight gripping

relation with the exterior of said tube for resiliently supporting and sealing same on and to said rigid junction box means whereby the periphery of said one end of the tube is sealed within said junction box means, and electric circuit means connected to said heating element comprising an elongated tubular member disposed concentrically of the upper end of said tube and spaced radially from the periphery of the tube, said member being rigidly secured to said junction box means with one end thereof projecting beyond said one end of the tube, a slip nut threaded on the other end of said member, a resilient ring circumscribing said tube and compressed between said slip nut and said member and gripping said tube, and a gas-impervious sealing compound between said member and said tube.

7. An immersion heater comprising a tube, a heating element in said tube, junction box means having a central opening through which one end of said tube extends, a resilient ring circumscribing said tube near said one end thereof, means carried by said junction box means for compressing and expanding said ring into tight gripping relation with the exterior of said tube for resiliently supporting and sealing same on and to said rigid junction box means whereby the periphery of said one end of the tube is sealed within said junction box means, and electric circuit means connected to said heating element comprising a source of power for energizing said heating element, a safety fuse mounted above said one end of the tube and connected in series with and between said source and said heating element.

8. In a fused quartz electric immersion heater the combination of a vapor-tight air-tight junction box, a fused quartz tube secured to and extending from said junction box, the end of said tube remote from the box being closed, the opposite end of said tube being open and extending into the interior of said box, a vapor-tight air-tight seal between the periphery of said tube and said junction box, a heating element in said tube, and means for supplying electric energy to said heating element.

9. The heater according to claim 8 in which said last named means include conduit means having a vapor-tight connection with said junction box, and electric wires in said conduit means electrically connected to said heating element.

10. An electric immersion heater comprising a tube of fused quartz being closed at one end and open at the other, a heating element disposed in said tube and having leads extending through the open end of the tube, a conduit through which said leads extend to a source of electric energy, means connecting and sealing the exterior of the open end of said tube to said conduit and providing a continuous open passage from the interior of said tube to the interior of said conduit whereby air can pass between the interiors of said tube and said conduit.

11. The heater according to claim 10 in which the end of said conduit opposite from said tube is remote from said tube, said air passageway extending from the interior of the tube to said remote end of said conduit.

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